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Research Note

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INSECTS AFFECTING WESTERN WHITE PINE FOLLOWING DIRECT
SEEDING IN NORTHERN IDAHO¹

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ABSTRACT

Insect damage to direct-seeded western white pine (Pinus monticola Dougl.) on three clearcut areas that were prescribed burned in successive years was investigated in north central Idaho. Ground beetles ate seeds, and grasshoppers and cutworms ate seedlings in the field and in the laboratory. The amount of damage to seedlings was inversely related to the age of the burn. Insects only slightly restricted successful first-year development of western white pine following direct seeding.

Insects, mammals, birds, and fungi are the major biotic factors that destroy direct-seeded western white pine (Pinus monticola Dougl.) seeds and seedlings. Any one or a combination of these factors may limit the successful establishment of new stands following direct seeding.

Most evidence that insects are involved has been only circumstantial. Wahlenberg (1925) summarized the results of past direct-seeding projects in the northern Rocky Mountain region and attributed the death of an undetermined number of western white pine seedlings to cutworm larvae. Haig (1936) and Haig et al. (1941) noted that soil insects, chiefly cutworm (Noctuidae = Phalaenidae) larvae, were one of the most important direct agents of conifer seedling mortality in the western white pine type in northern Idaho. Schopmeyer (1939) and later Schopmeyer and Helmers (1947) determined that either cutting or clipping was one of the major kinds of injury during the first growing season to direct-seeded western white pine. They observed several forms of cutting in both screened spots and unscreened spots. They speculated that "cutworms, grasshoppers, and other insects may have had a part" in causing the damage. In a recent study of seedspotting in Oregon (Franklin and Hoffman 1968), insects, along with other animals (rodents, birds, slugs, shrews), were believed to account for one-third of the mortality of western white pine germinants.

¹Based on a part of a thesis entitled "Biotic factors influencing direct seeding of western white pine (Pinus monticola)" prepared by the senior author in partial fulfillment of the requirements for the master of forestry degree at the University of Michigan in May 1964.

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Since in most of these past studies insects were only suspected as being responsible for clipping injuries, our objectives in this study were to (1) identify the most important insects damaging seeds and seedlings of direct-seeded western white pine and (2) assess the extent of the damage. Since this study was completed, the management program of western white pine in the northern Rocky Mountains has been realigned (Ketcham, Wellner, and Evans 1968). As a result, planting and direct seeding of western white pine has been discontinued on an operational basis. However, we feel that the information presented here is still of value because of its application to direct seeding of other conifers in the northern Rocky Mountains.

STUDY AREA AND PROCEDURE

We conducted our studies in 1962 and 1963 in the Musselshell area of the Clearwater National Forest in northern Idaho. Three areas were selected, each of which had been clearcut, and then prescribed burned in successive years--1960, 1961, and 1962.³

In the fall of 1962, two 10-acre blocks were selected on each of the burned areas. In one block in each burn, two types of exclosures were set up, both designed to exclude vertebrates but not most kinds of invertebrates. One type of exclosure was a 2- by 2-foot wooden frame to which was fastened a covering of 1/4-inch hardware cloth. Four of these were sunk 8 inches into the soil on each of the three blocks. The other type was a cone-shaped exclosure with a covering of the same material. Five of these were set up on each of the same three blocks.

That same fall, 100 western white pine seeds were broadcast sown under each frame exclosure and six seeds were spot sown under each conical exclosure. All seeds were coated with Endrin, Arasan⁴ and aluminum powder as outlined by Spencer.⁵

In early spring of 1963, eight 1-foot-high (aboveground) 2- by 2-foot-square wooden frame exclosures were placed on each of the other three blocks. Each was covered with fine mesh Saran screening. These exclosures did not prevent insects from crawling under the frame, but did, no doubt, deter some insects from getting to the seeds and seedlings as well as keep out mammals and birds. Later that spring we removed the vegetation from within each exclosure and broadcast sowed 150 seeds. Prior to sowing, the seeds were chemically scarified with sulfuric acid and hydrogen peroxide to promote germination. These seeds had been taken out of a seedlot from which we had dissected 1,000 seeds, which were found to be free of seed insects.

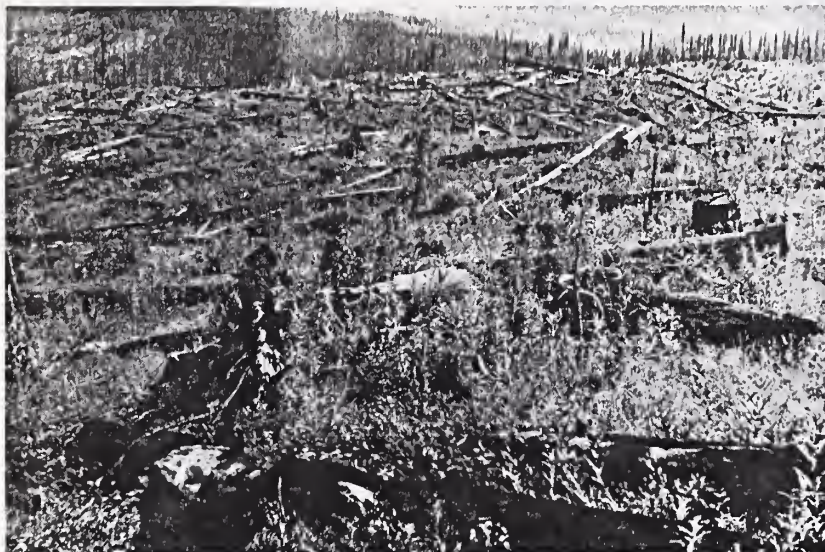
By 1963, the vegetation on the three burns was quite variable. On the 1960 burns, the main types of vegetation were grasses, sedges, and mosses, and occasionally some thistles (*Cirsium* spp.) and fireweeds (*Epilobium* spp.). On the 1961 burns, there were several species of annuals but mostly thistles and fireweeds (fig. 1). The 1962 burns had few plants until late in the spring and early summer of 1963 when thistles started to invade.

³This study is only a portion of a more comprehensive study concerning the biotic factors that influence the direct seeding of western white pine. The overall study was established by and is under the supervision of Raymond J. Boyd, Associate Silviculturist, Intermountain Forest and Range Experiment Station, stationed in Moscow, at the Forestry Sciences Laboratory, maintained in cooperation with the University of Idaho.

⁴These chemicals are usually used before normal seeding operations to protect seed from vertebrates, insects, and fungi. Mention of trade names does not imply endorsement by the USDA Forest Service.

⁵Spencer, D. A. A formulation for the protection of seed from animal damage. Wildlife Res. Lab., Bur. Sport Fish. & Wildlife, Denver, Colo. Unpub. Rep., 4 pp. 1959.

Figure 1.--Clearcut
burned in 1961 on
the Clearwater
National Forest.
Whistle's and
Fireweed predomi-
nated when this
photo was taken
in 1963.



All plots were examined periodically for germination and insect damage to seeds and seedlings. Insects suspected of causing damage were collected and caged in the laboratory with a supply of seeds or seedlings for food.⁶

RESULTS AND DISCUSSION

INSECT DAMAGE TO SEED

One percent of the coated seeds sowed on the plots covered by hardware cloth was apparently destroyed by insects. The damage to seeds resembled the feeding injury to Douglas-fir seeds caused by ground beetles (Coleoptera: Carabidae) as described by Dick and Johnson (1958) and Lawrence and Rediske (1962). We often collected the ground beetle, Amara erratica (Sturm) from the plots, especially on the 1960 burn. It was probably responsible for damage to the seeds; if so, it was the principal seed-destroying insect. In addition, we found chemically scarified seeds, which undoubtedly were damaged by carabids. However, we were unable to determine the incidence of damage.

In the laboratory, A. erratica readily ate chemically scarified seeds; the chemical treatment removed the outer seed coat, which made the soft inner tissue easily accessible. The beetles died, however, after feeding on seeds coated with Endrin, DDT, and aluminum powder.

⁶We would like to acknowledge the assistance of P. J. Spangler and E. L. Todd, Insect Identification and Parasite Introduction Research Branch, Entomology Research Division, Agricultural Research Service, U.S. Department of Agriculture, Washington, D.C., and I. J. Cantrall, Professor of Zoology and Curator of Insects, Museum of Zoology, University of Michigan, Ann Arbor, Michigan, who identified the insects.

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Figure 2.--Cutworm damage to western white pine seedling. Seedling to left of toothpick has been severed by a cutworm larva, leaving a portion of the hypocotyl. An undamaged seedling is to the right.



INSECT DAMAGE TO SEEDLINGS

Insects damaged or destroyed about 25 percent of the seedlings growing on the barren-covered plots. The following tabulation shows damage to seedlings was greatest on plots in the 1960 burn, less on plots in the 1961 burn, and absent on plots in the 1962 burn.

<u>Year of burn</u>	<u>Seedlings developed</u>	<u>Seedlings damaged</u>	<u>Seedlings damaged (Percent)</u>
1960	215	95	44
1961	87	5	6
1962	94	0	0

The reason for the more extensive damage on the 1960 burn and the absence of damage on the 1962 burn was probably the greater abundance of insects on the older burn. In another phase of our studies, we collected soil and duff samples on each burn biweekly throughout the summer and found more insects and other invertebrates on the 1960 burn than on either the 1961 or the 1962 burn.

There were no seedlings damaged on the plots covered by hardware cloth on the 1961 and 1962 burns. Only 12 seedlings were clipped on the 1960 burn as shown below:

<u>Type of plot</u>	<u>Seedlings developed</u>	<u>Seedlings damaged</u>	<u>Seedlings damaged (Percent)</u>
Square (broadcast sown)	378	7	1.9
Round (spot sown)	83	5	6.0

The insects responsible for the damage to seedlings were larvae of one or more species of cutworm (Lepidoptera: Phalaenidae) and grasshopper nymphs and adults (Orthoptera: Acrididae and Tettigoniidae). It is of interest that cutworms and grasshoppers are the same kinds of insects that Wahlenberg (1925) and Schopmeyer and Helmers

(1947) suspected of damaging seedlings. We collected five species of grasshoppers within and around the plots: Melanoplus bivittatus (Say), M. packardii Scudder, M. indigens Scudder, Trimerotropis suffusa Scudder, and Anabrus longipes Caudell. All of these grasshoppers readily ate seedlings in the laboratory. The one cutworm that we were able to rear and identify was Euxoa sp.--probably holobera (Smith). This species also readily consumed seedlings in the laboratory. Several other unidentified cutworm larvae clipped western white pine seedlings in the laboratory.

Grasshopper and cutworm damage to western white pine seedlings can usually be distinguished from one another. Grasshoppers usually consume the entire hypocotyl clear down to the ground line while cutworm larvae sever the hypocotyl leaving a portion of it protruding from the soil (fig. 2). However, we are not sure what percentage of the seedling damage can be attributed to cutworms and what percentage to grasshoppers, because both were seen feeding on seedlings on plots in the 1960 burn before we observed the difference in feeding damage. Cutworm larvae were abundant on the area during May and June while grasshoppers did not become noticeably abundant until the end of June. Similar damage to slash pine, Pinus elliottii Engelm. seedlings is caused by an arctiid, Apantesis radians Wlk. (Lepidoptera: Arctiidae) in Florida (Ebel 1967).

Of the 12 seedlings clipped in the plots covered by hardware cloth, one was clipped in the spring and the other 11 were clipped during July or later. The five clipped in the plots covered by cones were distributed in four different plots. Cutworm larvae probably clipped the single seedling while grasshoppers no doubt cut the remaining 11, although cutworms generally clip seedlings in groups, according to Fowells (1940).

Of the 100 seedlings damaged within the Saran-covered plots, we suspect that at least 40 percent was damaged by cutworms. In the spring and early summer of 1963, the senior author on several occasions observed cutworm larvae on these plots during late evening examinations. During one examination in the spring, a cutworm larva was observed actually consuming a seedling. On that particular plot, 40 seedlings had already been clipped prior to this examination.

Some of the seedling damage on the plots within the 1960 burn may have been done by carabids. Although we did not observe carabids feeding on seedlings, they were frequently found on the plots after the seeds had germinated and the seedlings were growing. Nusslin and Rhumbler (1922) observed a carabid, Harpalus pubescens Muller, chewing off spruce seedlings just above the ground surface.

CONCLUSIONS

The season of 1963 was considered to be favorable for the establishment of western white pine by direct seeding; it appears that insects were not an exceptionally important factor in restricting such establishment. However, conditions in other years could result in higher populations of insects and result in greater damage to seeds and/or seedlings. Hence, insects are always a potentially limiting factor in the regeneration of western white pine by direct seeding.

The only invertebrates damaging western white pine seeds or seedlings were insects. Of these only three groups were involved: ground beetles, which damaged seed; and cutworms and grasshoppers, which damaged seedlings.

Seeding areas during the year of burning will result in the least amount of insect damage. The ground fire reduces insect populations, hence providing some protection for the seeds and newly developing seedlings.

Spring sowing of seeds treated with Endrin, Arasan, and aluminum powder prevents carabid damage to seeds.

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